

May 2015 Vol. 2 No. 5

National Aeronautics and  
Space Administration



KENNEDY SPACE CENTER'S  
**SPACEPORT**  
m a g a z i n e

**DRAGON  
ROARS  
INTO SPACE**

**CELEBRATING OUR HOME PLANET: EARTH DAY 2015**  
#NOPLACELIKEHOME



# KENNEDY SPACE CENTER'S SPACEPORT MAGAZINE CONTENTS

- 4.....Falcon 9 sends Dragon on sixth cargo run
- 8.....Boeing uses Langley to ensure astronaut safety
- 14.....Space Launch System work platforms arrive
- 18.....Visitor complex hosts event honoring Mother Earth
- 22.....Robotics team works green, takes silver
- 28.....Engineers focus on first of nine umbilical lines
- 32.....Motivated students focus on future
- 36.....STAR award honors commitment to recycling
- 38.....Apollo 13 team reflects on 45th anniversary
- 40.....SPINOFF: Mars technologies spawn wind turbines
- 42.....Mars technologies spawn durable wind turbines

**Front:** A SpaceX Falcon 9 rocket lifts off from Space Launch Complex 40 at Cape Canaveral Air Force Station carrying the Dragon resupply spacecraft on the sixth commercial resupply services mission to the International Space Station. Liftoff was at 4:10 p.m. EST. The Dragon capsule delivered 4,300 pounds of scientific experiments, technology demonstrations and supplies to support science and research investigations. For more about the International Space Station, go to <http://go.nasa.gov/1HUAYb0> Photo credit: NASA/Tony Gray

Like us on Facebook or follow us on Twitter to get the latest and greatest Kennedy Space Center updates.



[www.facebook.com/](http://www.facebook.com/)



[www.twitter.com/nasakennedy](http://www.twitter.com/nasakennedy)

## THE SPACEPORT MAGAZINE TEAM

### Editorial

Managing Editor ..... Amanda Griffin  
 Editor ..... Frank Ochoa-Gonzales  
 Assistant Editor ..... Linda Herridge  
 Copy Editor ..... Kay Grinter

### Writers Group

Anna Heiney      Bob Granath  
 Kay Grinter      Linda Herridge  
 Frank Ochoa-Gonzales      Steven Sicheloff

### Graphics Group

Richard Beard      Amy Lombardo  
 Lynda Brammer      Matthew Young  
 Greg Lee

## NASA'S LAUNCH SCHEDULE

**Date:** May 26 — 3:46 p.m. EDT  
**Mission:** Expedition 44 Launch to the station.

**Description:** Kjell Lindgren of NASA, Kimiya Yui of JAXA and Oleg Kononenko of Roscosmos launch aboard a Soyuz spacecraft from the Baikonur Cosmodrome, Kazakhstan to the International Space Station.

**Targeted Date:** June 19 — 1:51 p.m. EDT

**Mission:** SpaceX CRS-7 Resupply Mission to International Space Station

**Description:** Launching from Cape Canaveral Air Force Station in Florida, SpaceX's seventh commercial resupply mission under NASA contract to the space station will deliver several tons of supplies, including new science experiments and technology research.

**Date:** July 22 — Time TBD

**Mission:** Jason-3 (NOAA)

**Description:** Jason-3, a mission led by the National Oceanic and Atmospheric Administration (NOAA) is the latest in a series of U.S.-European satellite missions that have been measuring the height of the ocean surface for 23 years.

**Date:** Aug. 6 — Time TBD

**Mission:** Progress 60P Cargo Craft

**Description:** The Progress resupply vehicle is an automated, uncrewed version of the Soyuz spacecraft that is used to bring supplies and fuel to the station.

**Date:** August — Time TBD

**Mission:** HTV5 Cargo Craft With CALET and MUSES

**Description:** The H-II Transfer Vehicle (HTV) is JAXA's unmanned cargo transfer spacecraft that delivers supplies to the station. CALorimetric Electron Telescope (CALET) is an astrophysics mission. Multi-User System for Earth Sensing (MUSES) is a precision-pointing platform that will mount externally to the station.





# I am

# KENNEDY

## SPACE CENTER



### JONATHAN “JD” DAVIS

I am an electrical engineer in the Voice and Imagery branch where I lead the Extended Voice System (EVS) and Timing and Countdown System at Kennedy Space Center. EVS provides Kennedy employees access to our mission critical voice system, known as OIS-M or MOVE, through a PC or mobile device. The Timing and Countdown System provides signals that support launch and the various countdown clocks around center, including the new Press Site clock.

Originally from Palm Harbor, Florida, I completed the U.S. Naval Nuclear Power and Propulsion Program and was later stationed in Pearl Harbor. I returned to the mainland to attend the University of South Florida and interned at Kennedy my senior year through the Pathways program. I was picked up full time in January of 2014 upon graduating with my bachelor's in electrical engineering.

Working at Kennedy is an absolute dream come true! There's nothing cooler than knowing that what I do somehow impacts the future of space travel. I love it when friends tell me about something they saw on the news involving the space program, or when they ask me how NASA throws a party (they plan-et!). My favorite experience has to be sitting on console in the Launch Control Center for EFT-1 and watching my systems work on launch day. I hope to be in the firing room when we finally send the first humans to Mars!

# CRS-6 SCIENCE

ISS

## Falcon 9 roars skyward, sends Dragon on sixth cargo run

BY STEVEN SICELOFF

**A** Falcon 9 rocket and Dragon spacecraft headed off the Earth on April 14 loaded with research so astronauts on the International Space Station can conduct experiments for the Earth and help scientists understand human reactions on long-duration flights like those required for a journey to Mars.

Known as CRS-6, for the sixth cargo resupply mission, the launch was the second station-related flight of the year for the Hawthorne, California-based SpaceX. The Falcon 9 v1.1 hit the instantaneous launch window at 4:10:41 p.m. EDT to rise above the lightning towers at Space Launch Complex 40 before arching over slightly to place it on a precise course to the space station orbiting some 257 miles above the planet. The first stage shut off its engines and separated on schedule with the second stage taking over lifting work and completing Dragon's voyage. It took three days for the spacecraft to reach the orbiting laboratory to deliver its supplies.

"Five years ago this week, President Obama toured the same SpaceX launch pad used today to send supplies, research and technology development to the ISS," said NASA Administrator Charles Bolden. "Back then, SpaceX hadn't even made its first orbital flight. Today, it's making regular flights to the space station and is one of two American companies, along with The Boeing Company, that will return the ability to launch NASA astronauts to the ISS from U.S. soil and land then back in the United States. That's a lot of progress in the last five years, with even more to come in the next five."

Friday, April 17, saw the Dragon approach the station on the horizon and carefully close the gap with each mile. Controlled robotically and with its own onboard systems, the spacecraft moved within reach of the station's 57-foot-long robotic arm. Ground controllers and station astronauts then maneuvered the Dragon to a port on the station where it will be berthed for the 5-week duration of the mission.

Astronauts opened the hatch to Dragon over the weekend and began unpacking the supplies before beginning some of the experiments that will be conducted, completed and returned to Earth during the mission.

The spacecraft was loaded with more than 2 tons of material, including items needed for 40 of the 250-plus experiments to be conducted by the station crews during Expeditions 43 and 44. Some of the experiments will focus on astronaut Scott Kelly, one of two men who recently began a yearlong mission on the orbiting laboratory so they can help determine changes and possible solutions to several dilemmas posed by extended missions. The work is crucial to NASA's knowledge of the effects on astronauts of missions to distant worlds including Mars.

One of the experiments will explore the changes in common bone cells of mice to see what changes in the cells in microgravity. Astronauts routinely lose bone mass during missions and researchers want to stop that bone density drop-off. The field also is of deep interest on Earth where any solution to the problem for astronauts also may apply

to people on Earth suffering from osteoporosis.

Scientists also want to determine how much fluid shifts in the body in weightlessness so they can figure out whether changes in astronauts' vision are related to additional pressure in the brain from fluids that gravity would otherwise force into lower parts of the body.

Some of the research focuses on synthetic muscle to see how it withstands radiation in low-Earth orbit. Artificial muscles could one day replace some of the metal components in robots to give them more human capabilities without reducing their capacity to perform tasks that would help astronauts on the station.

The Dragon's scientific contribution will not end with the delivery of its 4,300 pounds of experiments and equipment. Astronauts will pack the spacecraft with some 3,000 pounds of used gear and unneeded packaging. Completed science experiments also will be loaded into the capsule. After about five weeks in orbit, the Dragon will separate from the station and fly an automatic trajectory to return to Earth through the atmosphere and parachute to the Pacific Ocean off the coast of California.

After retrieval, the Dragon can be unloaded and the hardware sent to its home center for analysis where necessary. Scientists will get their work back, too, for more evaluation as new research is considered for upcoming missions on the station.







Click Here  
to  
Spot the  
Station

As the third brightest object in the sky  
the International Space Station is easy  
to see if you know when to look up.



Above: Expedition 43 Flight Engineer Samantha Cristoforetti of the European Space Agency, with the assistance of Expedition 43 Commander Terry Virts of NASA, successfully capture the SpaceX Dragon spacecraft with the space station's robotic arm April 17 at 6:55 a.m. EDT, while the station was traveling 257 statute miles over the Pacific Ocean just east of Japan. Photo credit: NASA

A SpaceX Falcon 9 rocket lifts off from Space Launch Complex 40 at Cape Canaveral Air Force Station carrying the Dragon resupply spacecraft on the sixth commercial resupply services mission to the International Space Station on April 14. The Dragon capsule will deliver 4,300 pounds of scientific experiments, technology demonstrations and supplies to support science and research investigations.

Photo credit: NASA/Tony Gray and Tim Powers





The Rotary National Award for Space Achievement (RNASA) Foundation awarded the 2015 National Space Trophy to Bob Cabana, director of Kennedy Space Center, former NASA astronaut on four space shuttle missions, and retired United States Marine Corps Colonel. The award was made during the 29th National Space Trophy gala April 24 in Houston, Texas.

The National Space Trophy is presented annually to an outstanding American who has made major contributions to our nation's space program. Nominations are voted upon by the RNASA Foundation's Board of Advisors that includes a who's who list of individuals intimately involved with the space program, including NASA center directors, presidents of aerospace corporations, military, news media, academic and political leaders, and previous Trophy winners. Cabana was nominated by Dr. Ellen Ochoa, director, NASA Johnson Space Center in Houston, Michael L. Coats, former director, NASA Johnson Space Center, Rick Hieb, vice president of Lockheed Martin Civil Programs, John Zarella, Elliot Holokauahi Pulham, chief executive officer of Space Foundation, and Dr. Michael D. Griffin, former NASA administrator, and chairman and chief executive officer (CEO), Schafer Corporation, "for his exceptional leadership and executive guidance in leading the evolution of the NASA Kennedy Space Center as the world's premier multi-user spaceport in support of NASA's exploration goals."

To read the complete story, visit: <http://www.nasa.gov/centers/kennedy/news/release-20150424.html>





A Florida East Coast (FEC) Railway GP40-2, a regular FEC freight service locomotive, pulls the last two NASA Railroad locomotives from Kennedy Space Center. The two locomotives, EMD SW 1500s, will be delivered to new homes on short-line railroads.

Locomotive No. 1 will be used by the Natchitoches Parish Port in Natchitoches, Louisiana. Locomotive No. 2 already has been delivered to the Gold Coast Railroad Museum in Miami for restoration and eventual use. Locomotive No. 3 will be used by the Madison Railroad in Madison, Indiana, for regular freight service and passenger excursion train service.

All three locomotives originally were acquired by NASA in 1983 from the Toledo, Peoria and Western Railroad. Photo credit: NASA/Kim Shiflett

# TUNNEL

## Boeing uses Langley expertise to ensure astronaut safety

CONTRIBUTED BY SASHA CONGIU  
NASA'S LANGLEY RESEARCH CENTER

Whether testing a model of the Boeing CST-100 capsule in a wind tunnel or dropping it in water, researchers and engineers have one common goal: astronaut safety. That's because safety is a top priority for systems under development in partnership with NASA's Commercial Crew Program to launch crews to the International Space Station from America.

Throughout the development of the CST-100, Boeing is testing fundamental capabilities of its abort system using unique facilities and expertise at NASA's Langley

Research Center in Virginia. The testing is being completed under a reimbursable Space Act Agreement Boeing has with the center. The CST-100 features a pusher abort system that would push the capsule off its Atlas V rocket in the case of an emergency on the pad or during ascent, ensuring the safety of the crew on board.

"Our unique facilities and expertise enable us to collect dynamic stability data that is crucial to the design of a highly dynamic vehicle like Boeing's abort vehicle," said Vanessa Aubuchon, Langley's flight dynamics principal investigator. "Building

on lessons learned during similar tests for Orion's Launch Abort System and Crew Module resulted in a highly successful test that provided Boeing with the best possible characterization of the stability of their vehicle."

Each test, though inherently different, provided the team with the data necessary to better understand how the CST-100 system would operate during an abort scenario.

Langley and Boeing first tested a two-foot model in Langley's Transonic Dynamics Tunnel — the only facility in the nation that contains a test platform capable of replicating

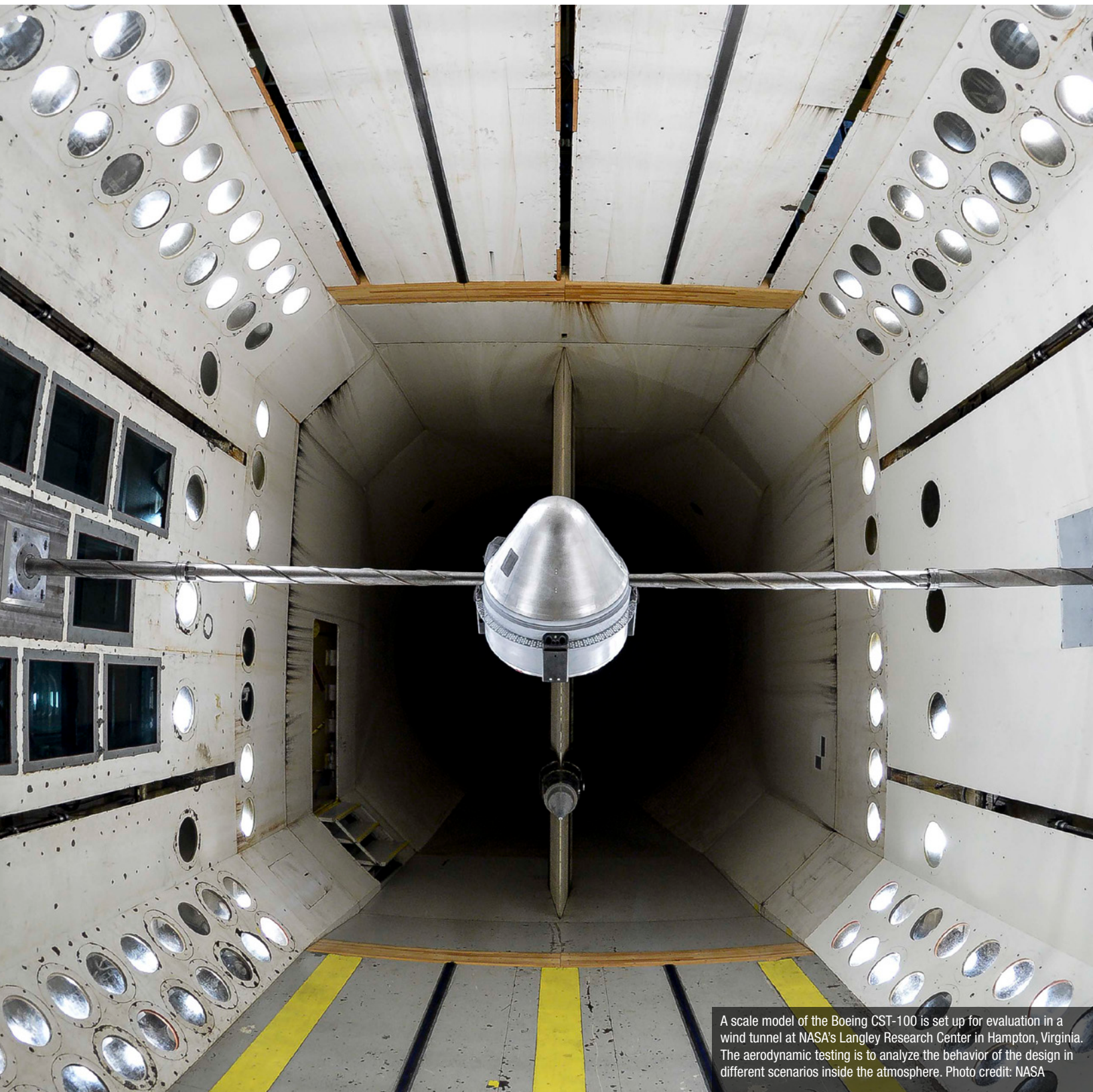


A CST-100 mock up splashes down during a test at NASA's Langley Research Center in Hampton, Virginia, during tests of the Boeing spacecraft's handling. Photo credit: NASA

ISS



# VISION



A scale model of the Boeing CST-100 is set up for evaluation in a wind tunnel at NASA's Langley Research Center in Hampton, Virginia. The aerodynamic testing is to analyze the behavior of the design in different scenarios inside the atmosphere. Photo credit: NASA





the environmental conditions the CST-100 would experience during flight.

“The Boeing CST-100 flies a familiar path through the atmosphere,” said Olman Carvajal, Boeing Commercial Crew wind tunnel test lead. “During an unlikely abort scenario, the vehicle is likely to experience different aerodynamic shifts, so we test the capsule model at different angles to ensure we can land the spacecraft safely in a real emergency event.”

In addition to wind tunnel testing, researchers from Langley and Boeing dropped a full-scale test article of the CST-100 into Langley’s Hydro Impact Basin, which looks like a large swimming pool.

The CST-100 will be certified to land on land, and while it’s unlikely the capsule will land in the water except in an emergency scenario, water drop testing at a variety of heights and angles is important to ensure a safe landing in any situation. Boeing will

use the data and results from these tests to support its certification efforts for launching NASA astronauts to the International Space Station.

Under Boeing’s Commercial Crew Transportation Capability (CCtCap) contract, the company will further test its abort capabilities during a series of thruster tests at White Sands Test Facility in New Mexico and during a pad abort test in early 2017.



Left: The CST-100 mock up was lifted high into the gantry at Langley to test the water landing characteristics of the design.  
Photo credit: NASA

Right: An engineer checks out a scale model of the Boeing CST-100 is set up for evaluation in a wind tunnel at NASA's Langley Research Center in Hampton, Virginia.  
Photo credit: NASA





# KSC Scenes







The Orion heat shield ground test article, secured in a shipping container, is being loaded into NASA's Guppy aircraft on the tarmac at the Shuttle Landing Facility at NASA's Kennedy Space Center. The container will be transported to Lockheed Martin Space Systems Company near Denver, Colorado. For more information, visit [www.nasa.gov/orion](http://www.nasa.gov/orion). Photo credit: NASA/Kim Shiflett



# PLATFORMS

## First set of Space Launch System work platforms arrive

BY LINDA HERRIDGE

**T**he first half of a new set of work platforms that will be used to access, test and process NASA's Space Launch System (SLS) rocket and Orion spacecraft arrived April 10 at Kennedy Space Center. The platform is half of a pair that will be installed in High Bay 3 of the Vehicle Assembly Building (VAB) that NASA has used to prepare rockets for launch since the Apollo program.

The SLS will send astronauts aboard Orion to explore deep-space destinations, including an asteroid placed into orbit around the moon, and eventually Mars. The SLS will be the largest launch vehicle ever built and more powerful than the Saturn V rocket.

"Arrival of the first platform marks a major milestone for the future of NASA and spaceflight," said Edsel Sanchez, the Ground Systems Development and Operations Program VAB Site Project manager.

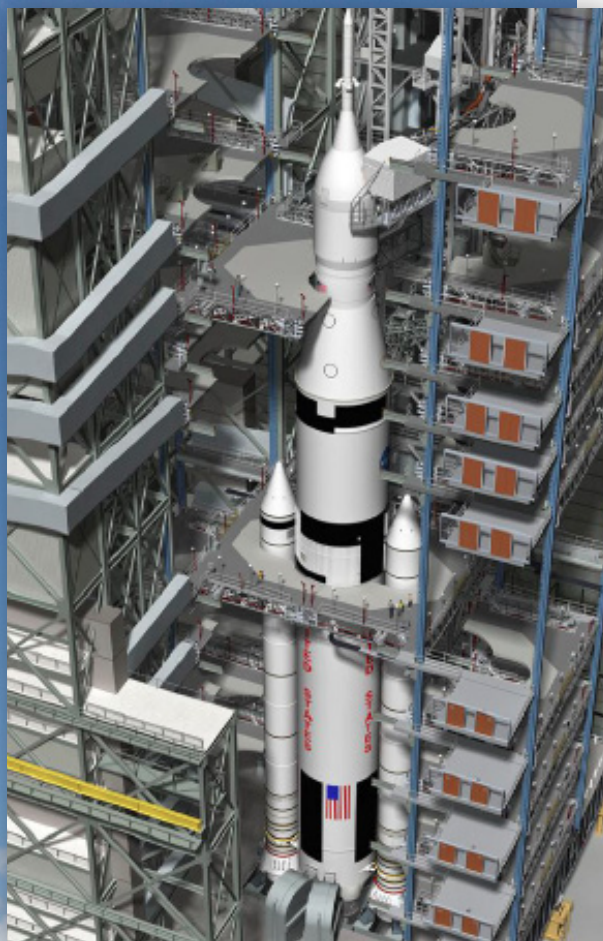
For now, the giant steel platform, 38 feet long and 62 feet wide, was set up on a test stand in a staging area in the west parking lot of the VAB. The platform will be attached to rail beams which will provide structural support and contain the drive mechanisms to retract and extend it. When attachments have been completed, the platform will be moved into VAB High Bay 4, where ground support technicians will get busy installing the mechanical, electrical and plumbing systems on it. When ready, the platform will be hoisted into position for installation on towers E and F in High Bay 3 using either the 325- or 250-ton crane.

A total of 10 levels of new platforms — 20 platforms altogether — will surround the rocket and spacecraft and provide access for testing and processing in High Bay 3. The platforms were designed to move in and out, and translate up and down as needed to accommodate different configurations of the SLS and other government and commercial vehicles.





# S for SUCCESS



Above: An artist illustration of the new work platforms surrounding NASA's Space Launch System and Orion spacecraft in High Bay 3 of the Vehicle Assembly Building at Kennedy Space Center. Photo credit: NASA

A flatbed truck, carrying the first half of a new set of work platforms, arrives at the Vehicle Assembly Building at Kennedy Space Center. A total of 10 levels of new platforms, 20 platforms altogether, will surround the SLS rocket and Orion spacecraft and provide access for testing and processing in High Bay 3. Photo credit: NASA/Jim Grossmann

This platform, designated "K," will be about 86 feet above the VAB floor. Both halves will provide access to the SLS core stage and solid rocket boosters. Working from the top down, the other platform levels are A through H and J.

Twenty new elevator landings and access ways are in the process of being constructed for each platform level. The high bay also will accommodate the 355-foot-tall mobile launcher that will carry the rocket and spacecraft atop the crawler-transporter to the launch pad.

"This is a very exciting time for NASA and Kennedy Space Center as we prepare the VAB for the SLS rocket," Sanchez said. "It's an honor to make history and be part of the team that is working hard to bring NASA's vision to fruition."

In 2013, all of the space shuttle work platforms in High Bay 3 were removed to make way for the new platform system that is designed to support processing of the SLS rocket and Orion spacecraft, and could support other exploration vehicles.

Sanchez said the last time a VAB high bay was totally upgraded or modified was in the 1970s, during the transition from the Apollo Program to the Space Shuttle Program.

NASA awarded a contract to modify High Bay 3 to the Hensel Phelps Construction Co. of Orlando, Florida, in March 2014. Steel LLC, of Scottdale, Georgia, is the subcontractor fabricating the huge steel platforms, and Sauer Co. in Oak Hill, Florida, is assembling the platforms.

In 2012, prototype platforms were tested at the center's Launch Equipment Test Facility, and studies were completed to understand the kinds of mechanisms needed to move platforms up and down.

New platforms will continue to arrive at Kennedy throughout the year, helping to transform High Bay 3 into the starting point for NASA's exploration missions to deep-space destinations.



## KSC Scenes

A ground support technician works on hardware in between the front of the crawler-transporter 2 treads in High Bay 2 inside the Vehicle Assembly Building at Kennedy Space Center on March 31. The Ground Systems Development and Operations Program at Kennedy is overseeing the upgrades to the 50-year-old crawler.

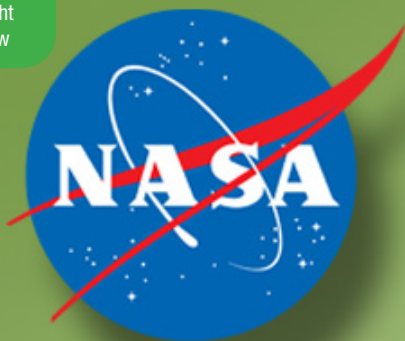
Photo credit: NASA/Dimitri Gerondidakis











# #NoPlaceLikeHome

## Visitor complex hosts event honoring Mother Earth

BY BOB GRANATH

Since the earliest days of America's efforts to explore space, NASA has used the vantage point of Earth orbit and beyond to increase its understanding of the world, improve lives and safeguard the future. This effort was highlighted in the late 1960s as Apollo astronauts returned spectacular images of Earth taken during their historic trips to the moon. At about the same time, the growing environmental movement led to the first Earth Day in the United States, taking place April 22, 1970.

"Observing our home is at the core of NASA's mission, and it continues to be a dynamic and growing area of our activity," said NASA Administrator Charlie Bolden in an Earth Day message to agency employees and contractors. "We want to know how our planet works, how we affect it, and how it might change in the future."

In celebration of the 45th Earth Day and in keeping with this year's national theme, "It's Our Turn to Lead," NASA and Delaware North hosted an educational event at the Kennedy Space Center Visitor Complex on April 22 with activities throughout the day for employees and park guests.

Kelvin Manning, Kennedy's associate director, pointed out that during the past 45 years, Earth Day has become a global event designed to demonstrate support for environmental protection.

"Today, we join more than one billion people in 192 countries participating in Earth Day activities," he said.

Manning also noted that NASA continues to be a world leader in Earth and climate science, providing unique perspectives of Earth from space.

"From space, we can see some of the changes taking place on

the Earth," he said.

One example Manning referenced is an upcoming international mission to measure the levels of the world's oceans.

"In July, NASA will launch the Jason-3 satellite in a cooperative effort with our partners in Europe," he said.

Jason-3 is the fourth in a series of spacecraft designed to measure the height of the ocean surface. These measurements provide scientists with crucial information about circulation patterns in the ocean and about both global and regional changes in sea level. It is a joint endeavor between NASA, the National Oceanic and Atmospheric Administration, the National Centre for Space Studies (the French space agency), and EUMETSAT, the European Organization for the Exploitation of Meteorological Satellites.

In addition to remarks by Manning, the day's events

included demonstrations by more than 50 exhibitors, including representatives of the Merritt Island National Wildlife Refuge, Canaveral National Seashore, Brevard Zoo and General Motors watched a demonstration by the FIRST robotics team and their recycling robot. The FIRST competition is a nationwide program that matches professionals with young people to solve an engineering design problem in a contest involving robots. Another educational exhibit included entries in the Earth Day poster contest, submitted by local elementary school children.

The keynote speaker for Kennedy's Earth Day event was former space shuttle astronaut Story Musgrave who presented a program called, "In Touch, and in Love with the Cosmos — the Heavens, the Earth, and All the Other Creatures on the Journey."

In his presentation, Musgrave



shared his thoughts on imagery photographed on his six space shuttle missions. In doing so, he explained his belief that people must respect and care for our home planet.

"Nature only draws curves, man draws lines," Musgrave likes to say.

Musgrave was a mission specialist on STS-6 in 1983; STS-51F in 1985; STS-33 in 1989; STS-44 in 1991; STS-61, the first Hubble Space Telescope servicing mission, in 1993; and STS-80 in 1996.

In addition to operating a palm tree farm near Orlando, Musgrave now has media production companies in Orlando and Sydney, Australia.

Bolden noted that NASA continues to do its part in caring for Earth.

"We don't have all the answers yet, but we're making progress," Bolden said. "We are steadily increasing the known, and decreasing the unknown about how Earth is changing. Knowledge is a powerful tool, and with it we can all be better stewards of our home planet."

NASA has led in developing new ways to observe and study Earth's interconnected natural systems with long-term data records. The agency freely shares this unique knowledge and works

with institutions around the world to gain new insights into how Earth is changing. This has been a key part of America's space program since its inception.

On Jan. 31, 1958, Explorer 1 was the first satellite launched by the United States. Orbited as part of the nation's participation in the International Geophysical Year, it was the spacecraft that discovered the Van Allen radiation belts surrounding Earth.

Starting in 1972, the Landsat program is the longest running effort for acquisition of satellite imagery of Earth. The most recent was Landsat 8, launched in 2013. The instruments on the Landsat satellites have captured millions of photographs. These images, archived in the United States and at Landsat receiving stations around the world, provide a resource for research and applications in agriculture, geology, forestry, regional planning and education.

Another example of this ongoing effort launched in 2014, NASA's Orbiting Carbon Observatory-2 (OCO-2), which is now is collecting precise global measurements of carbon dioxide in the Earth's atmosphere. The data will provide scientists with a better idea of the chemical compound's impacts on climates



# Earth Day

## 45 YEARS OF CHANGE





Sue Small of the Florida Wildlife Hospital holds a barn owl as part of their exhibit during Earth Day activities at the Kennedy Space Center Visitor Complex. Photo credit: NASA/Dimitri Gerondidakis

around the world. Scientists also are analyzing the data to develop a better understanding of the natural processes and human activities that regulate the abundance and distribution of this important atmospheric gas.

Earlier this year, the Soil Moisture Active Passive, or SMAP, satellite was launched. SMAP is a remote sensing mission designed to measure and

map the Earth's soil moisture distribution and provide freeze/thaw measurements with unprecedented accuracy, resolution and coverage. These measurements will be used to enhance understanding of processes that link the water, energy and carbon cycles, and to extend the capabilities of weather and climate prediction models.

"Right now, including those

recent launches, NASA has 20 spacecraft orbiting Earth and gathering amazing science data," Bolden said. "They can see carbon dioxide in the air, water reserves below ground, the heat our planet is absorbing, and the inside of hurricanes — amazing stuff!"

Through data returned by spacecraft such as these, NASA's expertise in space and scientific

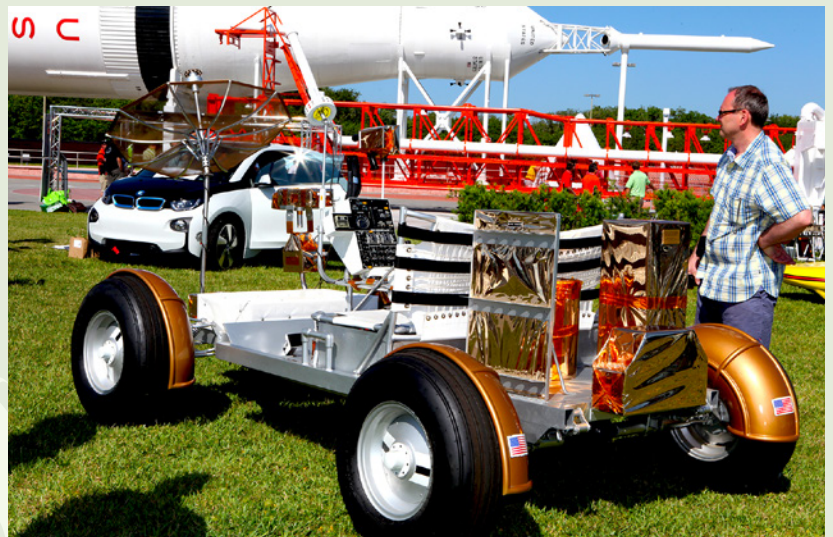
exploration is contributing to essential services provided to the American people by other federal agencies, such as weather forecasting and natural resource management.

"This is the first time in human history that we can really see and hope to understand how a planet lives and breathes," Bolden said "It's a tall order, but NASA is on it."





A young guest at the Kennedy Space Center Visitor Complex examines an experimental vehicle capable of 150 miles per gallon. In the background is a full-scale Saturn 1B rocket from NASA's Apollo Program.  
Photo credit: NASA/Dimitri Gerondidakis



Guests at the Kennedy Space Center Visitor Complex check out a Lunar Roving Vehicle trainer used during preparations for Apollo missions 15, 16, and 17. The battery-powered vehicle is an example of alternative fuel transportation on display during Earth Day activities. April 22 marked the 45th anniversary of the first such event in the United States. In celebration of Earth Day and in keeping with this year's national theme, "It's Our Turn to Lead," NASA and Delaware North Parks and Resorts Inc. hosted several educational activities throughout the day for spaceport employees and park guests.  
Photo credit: Dimitri Gerondidakis



# THINK PINK

## Robotics team works green, takes silver

BY FRANK OCHOA-GONZALES



It was all hands on deck as students from Cocoa Beach, Rockledge, Viera and Space Coast high schools gathered near the Shuttle Landing Facility at Kennedy Space Center to practice with their robots for the upcoming 2015 FIRST Robotics Championship, the final competition of the season.

The Kennedy-sponsored For Inspiration and Recognition of Science and Technology (FIRST) robotics software team, known as the Pink Team, was one of more than 600 teams from around the world that qualified for the four-day event April 22-25 at the Edward Jones Dome, home of the National Football League's St. Louis Rams. In all, more than 18,000 students, ages 6 to 18, participated in the tournament.

In this year's recycling-themed game, RECYCLE RUSH, teams took to the field, where they scored points by stacking totes

on scoring platforms, capping those stacks with recycling containers, and properly disposing of pool noodles, representing litter. In keeping with the recycling theme of the game, all game pieces are reusable or recyclable by teams in their home locations or by FIRST at the end of the season.

"The challenge this year is very different from last year," said Stephanie Dawson, a junior from Rockledge High School. "This is the tallest our robots have ever been."

Arriving April 22, the Pink Team pushed and/or carried its robot parts, spare motors, gears, tools and spirit paraphernalia to the pit area.

After making it through practice matches, a robot inspection, and the qualification matches, the Pink Team, also known as No. 233, found itself ranked eighth out of 76 teams going into the elimination rounds.

Each team had 10 matches to "show their stuff," increase their rankings and run their robot.

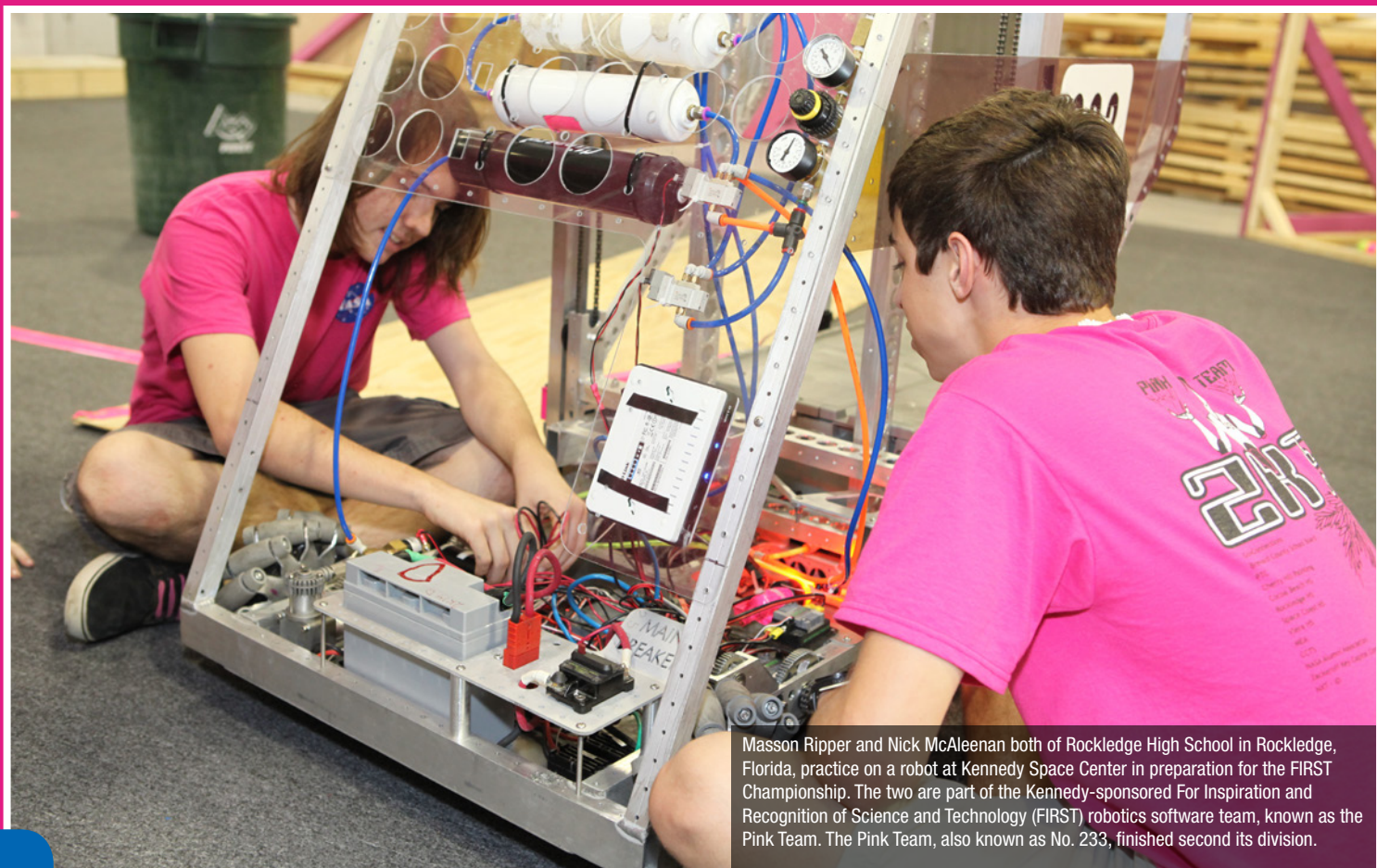
The Pink Team, a group of 24 students and three mentors, won in the quarterfinals and the semifinals.

The four-day event came down to a heart-pounding conclusion April 25 in front of a roaring crowd of more than 40,000.

The Pink Team was outscored in the final round but received medals for their second-place finish in the Carver Division. The team is pleased with the finish.

"I had no idea what I was getting myself into when I first went to the robotics meeting," said Caroline Hubbard, a senior at Cocoa Beach Junior/Senior High School. "I am so proud of our team and our robot."

Other divisions included: Hopper, Curie, Archimedes, Galileo, Carson, Newton, and



Masson Ripper and Nick McAleenan both of Rockledge High School in Rockledge, Florida, practice on a robot at Kennedy Space Center in preparation for the FIRST Championship. The two are part of the Kennedy-sponsored For Inspiration and Recognition of Science and Technology (FIRST) robotics software team, known as the Pink Team. The Pink Team, also known as No. 233, finished second its division.



Tesla. Each division had about 76 teams.

The Pink Team's mentors are Andy Bradley of Kennedy's Engineering Directorate; Mike Dininny, an engineering technician at Kennedy; and Marian Passmore, a math teacher at Rockledge High School. Passmore has been with the team since 1999, the Pink Team's first robotics season.

"The most valuable tools we have are our mentors," said Madison Hickman, a junior at Viera High School. "Having the knowledge they have, the tricks of the trade, has been really helpful."

This season, the team traveled to the Southern Georgia Classic and the Alamo Regional, where they finished as finalists and qualified for the world championship.

In the final regional, the Queen City Regional in Cincinnati, Ohio, the group took home the gold, finishing first. Once again, they qualified for the world championship.

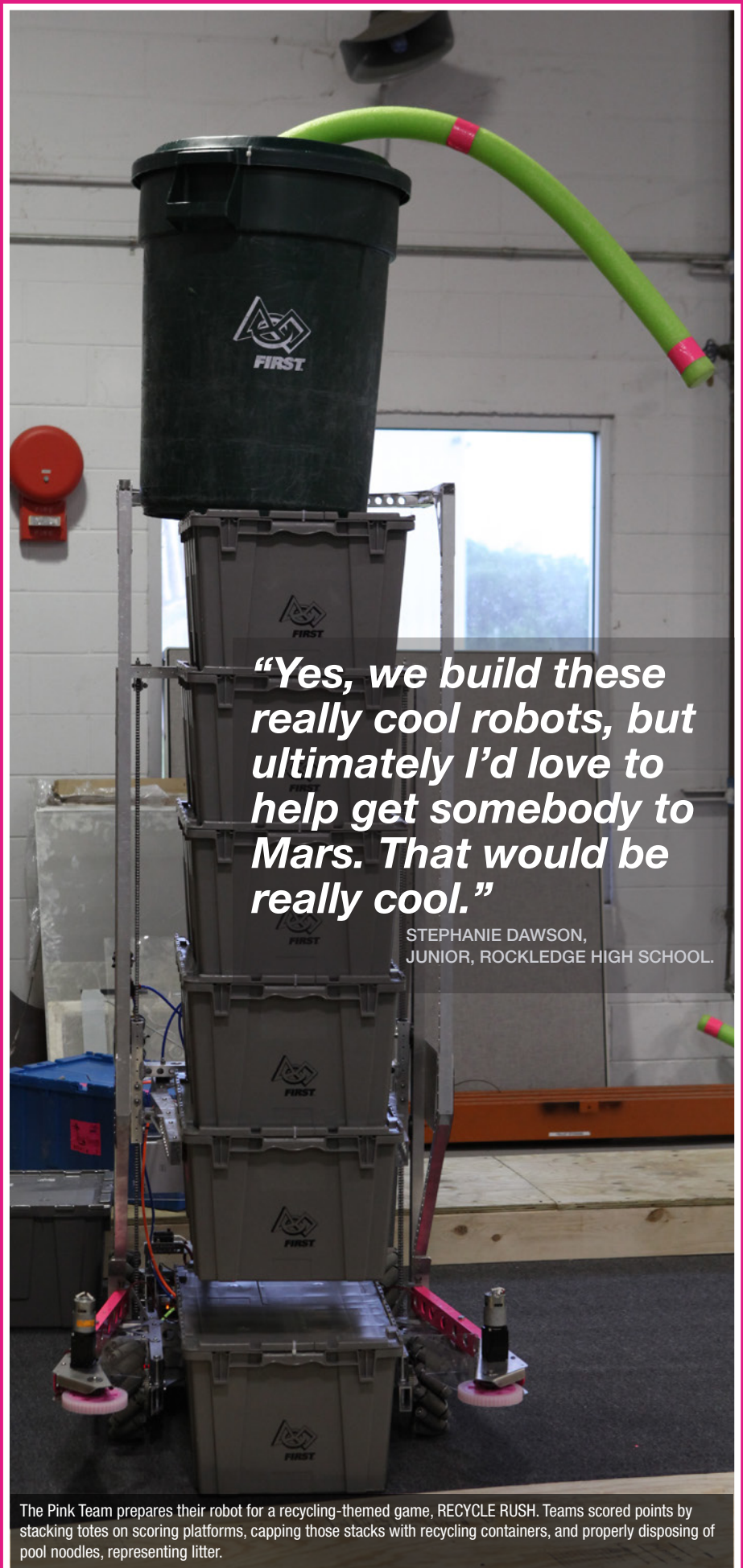
The team was a finalist at the Alamo regional in San Antonio, Texas, too.

"The Pink Team really makes FIRST Robotics an adventure from the build season, to the traveling, the events and the people we meet," said Madison Danielle Dininny, a junior at Cocoa Beach Junior/Senior High School. "We're able to make memories we'll never forget."

Recently, the Pink Team built a robot, called the Eastern Range Weatherbot, that releases weather balloons during bad weather conditions. Last year, two launches were scrubbed because of lightning that prevented weather balloon releases. The 90-pound robot sports six all-terrain wheels, over a mile of travel range, headlights for nighttime launches and two 330-watt motors.

The Pink Team also developed a 100-pound, life-saving robot for the police department in Rockledge, Florida. It includes a camera, can record video, and has infrared LEDs and a spotlight for low-light situations. Police said the robot is ideal in crisis situations, keeping officers out of danger.

"Yes, we build these really cool robots," Dawson said, "but ultimately, I'd love to help get somebody to Mars. That would be really cool."



***"Yes, we build these really cool robots, but ultimately I'd love to help get somebody to Mars. That would be really cool."***

STEPHANIE DAWSON,  
JUNIOR, ROCKLEDGE HIGH SCHOOL.

The Pink Team prepares their robot for a recycling-themed game, RECYCLE RUSH. Teams scored points by stacking totes on scoring platforms, capping those stacks with recycling containers, and properly disposing of pool noodles, representing litter.



## KSC Scenes

In High Bay 2 inside the Vehicle Assembly Building at Kennedy Space Center, ground support technicians assist as a large crane lifts the steering arm away from crawler-transporter 2 (CT-2). The steering arm moves in and out to steer the crawler truck.

The Ground Systems Development and Operations Program at Kennedy is upgrading the 50-year-old crawler to handle the increased load of the Space Launch System and Orion spacecraft on the mobile launcher as it travels to the pad. Photo credit: NASA/Jim Grossmann











As a tribute to Yuri Gagarin's first human spaceflight in 1961, the Lunar Surface Applications 5 Workshop hosted a Yuri's Night panel April 15 in Cape Canaveral. Panelists included Dr. Ryan Kobrick of Space Florida; Thomas Potts of the Aquarius Reef Base; NASA astronaut Cady Coleman; and Annie Caraccio of Hawai'i Space Exploration Analog and Simulation.

Yuri's Night, the World Space Party, was celebrated around the planet in April including 222 official registered events in 48 countries and on all seven continents with two special recorded messages from the International Space Station's Commander Terry Virts and Flight Engineer Samantha Cristoforetti.

On April 12, 1961, Russian cosmonaut Yuri Gagarin became the first human in space, making a 108-minute orbital flight in his Vostok 1 spacecraft. Photo courtesy of Matthew Travis

**To read the complete story, visit: <http://go.nasa.gov/14hii4L>**



I am  
GSDO

National Aeronautics and  
Space Administration



**Charlie Blackwell-Thompson**  
Chief of the Test Management Office  
GROUND SYSTEMS DEVELOPMENT AND OPERATIONS



**Kennedy Space Center**  
Exploration Begins Here



# Umbilical UNDERGOES Tests

Engineers focus on first of nine Space Launch System ground support components before installation

BY LINDA HERRIDGE

**K**ennedy Space Center engineers recently tested equipment that will provide electrical power and data connections to the Space Launch System (SLS) rocket until it lifts off from its launch pad.

The SLS will be the world's most powerful rocket, launching the Orion spacecraft to send humans on deep space missions beyond low-Earth orbit. The SLS core with liquid fuel and two solid rocket boosters will provide the energy necessary to push the spacecraft to orbit.

The rocket and spacecraft will be put together in the Vehicle Assembly Building atop the mobile launcher platform, which will then carry the SLS out to Launch Pad 39B. A tower on the mobile launcher will have a series of lines connected to various stages of the rocket to provide the necessary power, fuel, and communications until launch. These umbilical lines must be able to provide the connections, release at lift off and retract to clear the way for lift off.

The Launch Equipment Test Facility (LETF) tested the first of two umbilicals that will connect to the rocket at the bottom outer edge of the booster, referred to as the aft skirt. The tests of the aft skirt electrical umbilical (ASEU) will confirm its design and function.

"This umbilical is the first of nine different types of umbilicals that will be put to the ultimate test before they are installed on the mobile launcher," said Jeff Crisafulli, NASA LETF manager.

The umbilical underwent a series of tests using the facility's Data Acquisition System and Vehicle Motion Simulator.

The Data Acquisition System is used to monitor and record about 80 channels of instruments during each test, including strain gauges, accelerometers, pressure transducers and load cells. The Vehicle Motion Simulator is a test structure capable of simulating all expected launch vehicle motions from rollout through about the first half-second of launch, when the umbilical is disconnected.

"This umbilical is especially critical because it acts like a telephone line and carries a signal to another subsystem on the mobile launcher called







the Launch Release System,” said Martin Grashik, NASA mechanical engineer and test engineer for all of the SLS mobile launcher umbilical tests at Kennedy. “The Launch Release System distributes the signal to the rest of the umbilicals and the SLS boosters actually give the release command.”

Several other test objectives included gathering data for comparison to analysis models, running and revising operating procedures, and checking to ensure the umbilical worked as intended.

A team at Kennedy ramped up for the tests March 2, which began with some basic umbilical functions to exercise the umbilical’s systems and a functional check of the lifting and lowering actuators.

During the next couple of weeks, the team completed a simulated connection of the umbilical to the mobile launcher. The test was similar to the procedures that will be run in the Vehicle Assembly Building to connect the umbilicals during assembly of each SLS rocket.

Testing became more involved on the Vehicle Motion Simulator as the umbilical was attached

to a representation of the flight umbilical carrier plate — the connection point on the booster — to test the range of motion of the umbilical’s compliance mechanism. The compliance mechanism allows the umbilical to accommodate differences in position between the umbilical that is permanently installed on the mobile launcher and the connection point on the booster’s aft skirt.

A series of launch and separation tests followed to simulate liftoff of the SLS.

Crisafulli said NASA also used the testing time in the facility to train the launch team on how to configure the launch accessories to support an SLS launch. After testing is complete, the umbilical will be installed on the mobile launcher.

The Ground Systems Development and Operations Program at Kennedy is overseeing the tests to verify that the umbilical meets all of the Space Launch System Program’s specifications for the entire umbilical system as NASA prepares for the first integrated launch of SLS and Orion, Exploration Mission-1.



Opposite: Preparations are underway to test the aft skirt electrical umbilical (ASEU) at the Launch Equipment Test Facility at Kennedy Space Center on April 6. A section of the ASEU will be attached to the flight-interface simulator on the facility’s vehicle motion simulator, to simulate lift off of the Space Launch System. Workers are applying grease to the flight-interface simulator to help seal the flight to ground connection from water or dust during the test. Photo credit: NASA/Kim Shiflett

Above: Workers prepare to test the aft skirt electrical umbilical (ASEU) at the Launch Equipment Test Facility at Kennedy Space Center on April 3. Wayne Crawford (orange hat), an instrumentation engineer; Steve Anderson (white hat), a test conductor; and Bob Gatewood (blue hat), a quality engineer; all on the Engineering Services Contract, check the ASEU connections before the test begins. Photo credit: NASA/Dimitri Gerondidakis



A vertical beam of light, representing a journey through space, is the central focus. It starts at the bottom with a bright orange and yellow sun, where a silhouette of a person stands with arms raised in triumph. Above the sun, the beam transitions through a yellowish-orange glow, then a blue and white nebula, and finally into a deep blue space filled with stars, galaxies, and a ringed planet. The beam is set against a dark background with vertical lines. The text "we're OUT there" is overlaid on the beam, with "OUT" in bold black and the rest in white. A large, faint "NASA" logo is in the background.

we're **OUT** there

***NASA is exploring our solar system and beyond to understand the universe and our place in it, unraveling its mysteries and searching for life among the stars. Image credit: NASA***





Senior Managers Russ DeLoach and Johnny Nguyen rap their way to victory with the “Green Team” during a recent student and Kennedy Space Center senior management event on April 7. Students in the KSC Pathways Program and the NASA Interns, Scholarships and Fellowships (NIFS) Program participated in a team building activity with 13 of KSC’s senior management team.

Each of the 10 teams were given 20 minutes to create a rap using a popular song and replacing lyrics with words such as KSC, LSP, GSDO, Commercial Crew and more.

The “Green Team” rap won with their version of “Beyoncé’s Lift Off.” Student members of the team included: Daniela Cortez, Shane Thompson, Hector Pagan Marrero, Jonathan Serrano Otero, Sean Sanders, and Benjamin Wallace.  
Photo credit: NASA



# VOCATIONAL VACATION



## Motivated students spend spring break focusing on future of space exploration

BY BOB GRANATH

During spring break, many young people head for the beach to check out the surf. On March 31, 25 students from Sebastian River High in Florida used their time off to travel to NASA's Kennedy Space Center to learn more about exploring space.

At the spaceport's Center for Space

Education, they learned about careers involving research aboard the International Space Station (ISS) and participated in hands-on experiences about living and working in low-Earth orbit and beyond.

The program was part of an effort established by the Center for the Advancement of Science in Space, called CASIS Academy. CASIS is a nonprofit organization tasked with managing, promoting and brokering research aboard the International Space Station's U.S. National Laboratory.

According to Nikki Hoier, an education specialist with CASIS Academy, the educational aspect of the organization provides speakers to make presentations about work on the ISS and provide an opportunity to tap into student interests and experiences. The academy's objectives also fit with NASA's goal to inspire and educate the scientists, technologists and engineers of tomorrow.

"In presentations like this, we get ISS investigators to talk about how technology being developed in space is a test bed for future deep-space exploration," she said. "We give middle and high school students an opportunity to 'get their hands dirty' in demonstration projects. Hopefully, some of those who may not have been considering science or engineering as a career will want to go that way and further their education."

Throughout its history, NASA has emphasized the need to inspire and engage students in STEM — science, technology, engineering and mathematics, leveraging the agency's unique mission and research.

"We invited Twyman Clements, president and chief executive officer of Space Tango in Lexington, Kentucky, to talk about developing student research projects that can be launched to the space station," Hoier said.



While sitting on a swivel stool, a Sebastian River High student holds a spinning bicycle wheel. Acting as a gyroscope, tilting the wheel will cause the student to move to the left or right. A rocket's guidance system can steer a launch vehicle in a similar manner. Photo credit: Cory Huston



“He wants to see middle and high school students get involved in projects such as learning in just one hour how to build a small satellite.”

Space Tango is a commercialization partner for Kentucky Space, a nonprofit enterprise involving a consortium of universities, as well as public and private organizations dedicated to designing and

Space was KySat-1, which flew as part of the NASA Educational Launch of Nanosatellites, or ELaNA, program. One element of KySat-1 is a camera. Its images are used in classrooms supporting outreach to Kentucky students in kindergarten through 12th grade.

ELaNA is managed by NASA's Launch Services Program at Kennedy. CubeSats are built in academic settings as an educational

went up to spend an entire year on the ISS. We want to learn more about how the body responds to microgravity, and we want to know about work we can do in that environment.”

On March 27, American astronaut Kelly and Russian cosmonaut Mikhail Kornienko launched to the ISS, planning to stay for twice as long as a typical crew. Researchers expect the one-year mission to yield beneficial knowledge on the medical, psychological and

***“It’s great to witness kids listen . . . see what’s out there and start to connect the dots.”***

*NIKKI HOIER,  
CASIS ACADEMY EDUCATION SPECIALIST*



leading innovative space missions within realistic budgets and objectives.

“An artificial satellite is any human-built object placed in orbit around any celestial body,” Clements said in describing to the students the basics of spacecraft circling Earth or other planets. “Basically, satellites do two things — make measurements and communicate.”

Artificial satellites are distinguished from natural satellites such as the moon which orbits the Earth.

Clements explained that since the earliest satellites in the 1950s, their work has become much more sophisticated. Orbiting spacecraft today are used for a large number of purposes such as satellites for Earth observation, communications, navigation, weather and research. Additionally, the International Space Station is the largest satellite ever built.

One of the programs Clements has worked on in collaboration with Kentucky Space is CubeSats. The organization is among those designing, building and operating these small research satellites. The first orbital CubeSat spacecraft launched by Kentucky

tool and to encourage interest in STEM education. The satellites are approximately four inches on each side, have a volume of about one quart and weigh no more than 2.2 pounds. Many have been delivered to the ISS and deployed from one of the station's robotic arms.

“In presentations like this we have seen students become interested in technology, science and engineering,” Hoier said. “It’s great to witness kids listen . . . see what’s out there and start to connect the dots.”

During their visit to Kennedy, the Sebastian River students broke into two groups. Half of the students participated in Clements’ presentation and the other a demonstration called “Living in Space.” After about an hour the students changed places.

Jen Hudgins, an education specialist with the Astronaut Memorial Foundation, focused on how ISS crews are working off the Earth, for the Earth.

“I spoke about what it’s like to live and work in space,” she said. “The presentation covered research going on aboard the space station and the fact that Scott Kelly recently

biomedical challenges explorers may face as part of NASA’s Journey to Mars.

“We also explain our new programs coming on line such as the Space Launch System and Orion,” Hudgins said. “I talk about the effort to reach Mars and what is needed to get there.”

NASA’s SLS is a new heavy-lift rocket, more powerful than any previously built. The SLS will be capable of sending humans aboard the agency’s Orion spacecraft to deep-space destinations such as an asteroid and Mars.

Hoier noted that after the students had lunch, they toured the Kennedy Space Center Visitor Complex during the afternoon.

“When the class, teacher and chaperones boarded their bus for home, all were happily tired from both their experiences and exploring the exhibits,” she said. “Many students declared the day would be remembered forever.”

According to Hudgins, the experience is all about encouraging STEM education.

“We want to give the students an idea of all the disciplines it takes to build a rocket or satellite,” Hudgins said. “Hopefully, we’ll inspire them to enter one of those fields.”

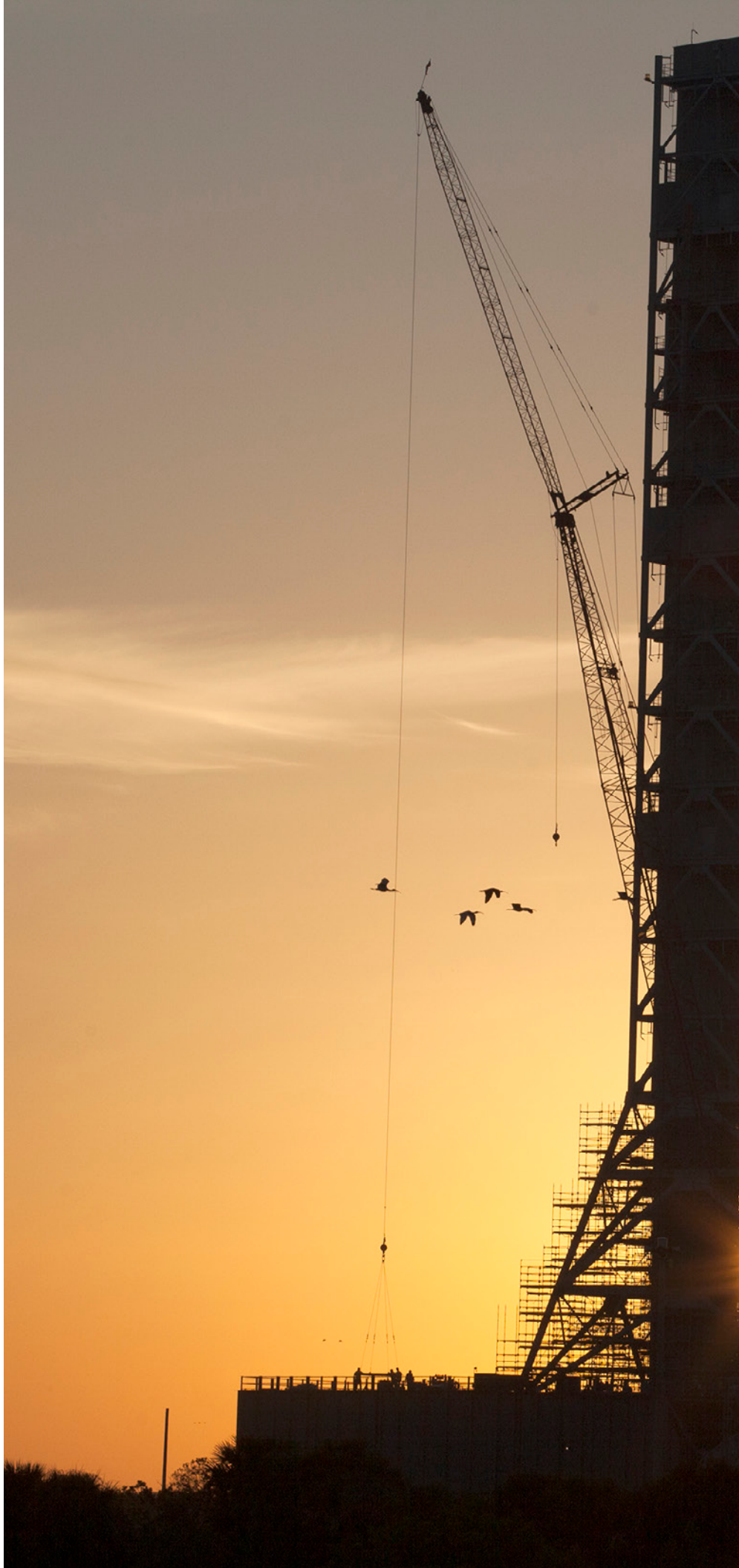


## KSC Scenes

A sunrise casts a golden glow on NASA's Mobile Launcher in the Launch Complex 39 area at Kennedy Space Center.

The Ground Systems Development and Operations Program at Kennedy is overseeing upgrades and modifications to the Mobile Launcher so it can carry the agency's Space Launch System and Orion Spacecraft to Launch Pad 39B.

Photo credit: NASA/Ben Smegelsky









# SHINING STAR

## STAR award honors commitment to recycling

BY BOB GRANATH

**K**imberly Moore knows our planet is changing and she's on it. Since 2013, the Kennedy Space Center's recycling system has streamlined its efforts to reuse materials with a Web-based portal called the Sustainable tracking Tool for Automated

Recycling, or STAR. An executive assistant with NASA contractor Wichita Tribal Enterprises, Moore was recently honored for her untiring work supporting efforts to preserve the environment by ensuring office material is recycled.

NASA continues to make a difference in people's lives. One way is by saving resources as well as increasing recycling revenue with the STAR portal. The effort is designed to process requests for emptying recycle collection bins or ordering new ones.

During a Kennedy Institutional Support Services III, or KISS III, contract staff meeting on March 17, Glenn Semmel, NASA's Environmental Management Branch chief at Kennedy, joined Annie Williams, a NASA Environmental Protection specialist, in presenting Moore with the 2014 STAR Top User Award.

The Environmental Management Branch of Center Operations created the STAR Award to honor efforts to support and use the recycling system.

According to Williams, the recycling program at Kennedy was originally established as a "milk run" process, with every recycle container emptied on a weekly or monthly basis. However, with the STAR Web-based portal, it is now an "on-demand" process, with containers emptied only when a service request is submitted.

"To do this, the Sustainable tracking Tool for Automated Recycling portal was created," Williams said. "Now employees submit a request when their recycling bin is about three-quarters full. Since we were looking for a way to both advertise the program and acknowledge employees who are using it, we came up with the STAR Award."

The STAR Award is presented annually to the single top user based on how many times someone submits a request. The award is a result of a NASA@WORK challenge, which encourages agencywide feedback.





## ***“The revenue we receive from recycling also comes back to Kennedy and is used to fund Sustainability projects.”***

ANNIE WILLIAMS,  
NASA ENVIRONMENTAL  
PROTECTION SPECIALIST

to Kennedy’s recycling program. “Catch an Environmentalist” recipients are presented certificates recognizing both individuals and teams that have notably contributed to environmental stewardship at the space center based on frequency of STAR’s use.

“Without these champions, we would not have a recycling program,” said Williams. “The revenue we receive from recycling also comes back to Kennedy and is used to fund Sustainability projects.”



Executive assistant Kimberly Moore, center, is presented the 2014 STAR Top User Award by Environmental Management Branch Chief Glenn Semmel, left, and NASA Environmental Protection Specialist Annie Williams on March 17. Moore was recognized for her support of the Kennedy Space Center recycling program by using the Sustainable tracking Tool for Automated Recycling (STAR) System. Photo credit: NASA/Kim Shiflett

“The star design on the plaque was made of plate glass windows removed from the firing rooms of Kennedy’s Launch Control Center, or LCC,” said Williams. “The windows were a permanent fixture on the LCC from 1963 until they were removed during a 2010 renovation project.”

Semmel and Williams also presented three “Catch an Environmentalist” Awards to Moore, Cindy Pfeil of InoMedic Health Applications Inc. and James Larubio of the Brevard Achievement Center. Pfeil and Larubio were recognized at staff meetings for their areas of work.

According to Semmel, the three were recognized for focused efforts contributing

Semmel explains that while recycling is an important part of protecting the environment, there is more to the overall effort.

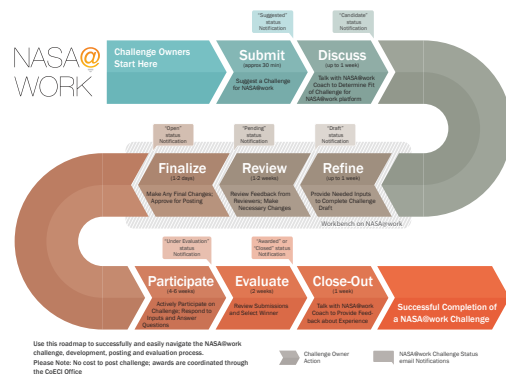
“Many of us primarily associate sustainability with the task of recycling,” said Semmel. “In fact, recycling is the largest environmental movement the world has ever known, especially given its reach into our professional and private lives and the numerous municipalities that perform the work. However, sustainability is much more. It spans environmental, economic and social equities. Along that ‘triple bottom line,’ every directorate at Kennedy can help transform our center into a 21st century premier sustainable spaceport.”

# NASA@WORK

## **Did you know?**

NASA@work is an internal crowdsourcing platform that provides NASA employees an unconventional and inventive way to help them solve problems associated with human spaceflight. In other words, NASA@work is a website used by employees (called Challenge Owners) who post problems and get solutions more efficiently and effectively. Those solutions come from other employees (called Solvers) and they come from across the agency. NASA@work is NASA’s very own internal crowdsourcing capability. And today, we are more than 11,250 strong and growing every day.

### NASA@work Challenge Owner Roadmap



For more information, go to  
<http://www.nasa.gov/content/nasa-at-work-welcome/>



# NASA'S FINEST HOUR

## Members of Apollo 13 team reflect on 45th anniversary

BY BOB GRANATH

**A** gala celebration recently took place at Kennedy Space Center's Apollo/Saturn V Center, celebrating the 45th anniversary of what has been termed "NASA's finest hour." The event was a reunion of key players in the mission of Apollo 13.

What was to have been the third lunar landing in April 1970, became a struggle to safely return the crew when their Apollo spacecraft was crippled by an oxygen tank explosion.

Apollo 13 commander Jim Lovell and lunar module (LM) pilot Fred Haise were on hand on April 11, 2015, to recall the events of 45 years ago. Also participating in a candid panel discussion were backup LM pilot Charlie Duke, support crew astronauts Vance Brand, Joe Kerwin, and Jack Lousma, along with flight directors Gerry Griffin, Gene Kranz and Glynn Lunney. These space icons shared their stories reflecting on the mission that brought global attention to the determination of a broad-based NASA team in government, industry and academia.

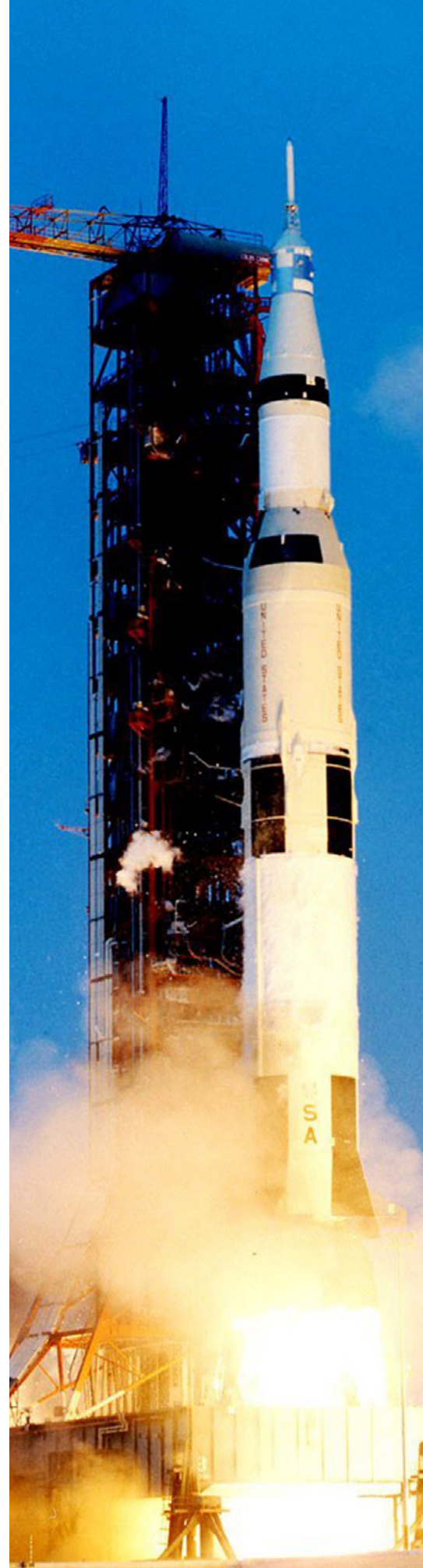
The evening's program began with a recorded video presentation by NASA Administrator Charlie Bolden who had high praise for those who successfully brought the Apollo 13 crew home.

"Together with (command module pilot) Jack Swigert, these men helped advance our exploration goals through their perseverance and level-headed thinking during a near-catastrophic emergency in space," he said. "Their experience made it possible for the rest of the Apollo Program to continue."

The Apollo 13 crew of Lovell, Swigert and Haise lifted off from Kennedy on April 11, 1970. It was a mission to explore the moon's Fra Mauro highlands. The third member of the crew was supposed to be Ken Mattingly, but he had been exposed to German measles and was replaced by his backup, Swigert.

Two days into the mission, with Apollo 13 about 205,000 miles from Earth, the astronauts heard a "loud bang." It was accompanied by fluctuations in electrical power and automatic firing of the attitude control thrusters.

"Houston, we've had a problem," Lovell said. "We've had a main B bus undervolt."



The Apollo 13 Saturn V lifts off from Launch Pad 39A at Kennedy Space Center on April 11, 1970. Photo credit: NASA



A “main B bus undervolt” indicated there had been an abrupt power loss from one of the command-service module’s two main electrical systems.

“Roger, main B undervolt,” said capsule communicator Lousma. “OK, stand by, 13. We’re looking at it.”

Kranz and members of the flight control team were looking, but initially, what they were seeing was confusing.

“The communications loops were chaotic for about 60 seconds,” Kranz said.

Haise explained it was equally unclear for the crew.

“We had seven caution and warning lights on,” he said. “Generally, there was never a failure in one system that would go across so many different systems.”

Lovell noted that a look outside would tell him more than the instrumentation in the CM.

“It really was not until I looked out the window and saw the oxygen escaping from the rear end of my spacecraft that I knew that we were in serious trouble,” he said.

“It began to become clear that we had moved into ‘survival mode’ when Jim looked out the window and said he was seeing venting out there,” Kranz said. “It was the oxygen tanks that were the source of the venting.”

One of two fuel cell oxygen tanks in the service module had exploded. Damaged Teflon insulation on the wires to the stirring fan inside oxygen tank 2 allowed the wires to short-circuit and ignite the insulation.

The fuel cells generated the command-service module’s electrical power by combining oxygen and hydrogen. When the oxygen tank ran dry, the remaining fuel cell shut down, leaving only the CM’s limited-duration battery power.

“Glynn (Lunney) recognized that we had a series of decisions to make relative to the path home so he was already down in the trench with the trajectory guys,” Kranz said.

The Mission Control “trench” was the front row of consoles closest to the tracking map. The flight controllers there included the flight dynamics officer, called FIDO, and the guidance officer, GUIDO.

“They came up with five return-to-Earth options,” Kranz said.

The lunar landing mission was aborted and the crew was forced to shut down the CM completely to save its battery power for

re-entry. The astronauts then powered up the lunar module to use as a “lifeboat.”

“When my (flight control) team came on, we were aware that the lunar module has lots of capability as a lifeboat,” Lunney said. “The problem was ‘how are we going to deploy that capability?’”

Kranz and Lunney next directed Lovell, Swigert and Haise to perform a 30.7-second firing of the LM’s descent engine to put the spacecraft on a return trajectory, looping

The LM’s stock of LiOH canisters was not sufficient to support the three-person crew during the four-day return. The lunar lander was designed to support two crew members. The CM had an adequate supply of canisters, but these were cube-shaped with the LM’s canisters cylindrical. Engineers were faced with needing to put a “square peg” in a “round hole.”

“Ed Smylie, who was chief of the crew systems division, got his team together to



The Apollo 13 crew, from the left, are commander Jim Lovell, command module pilot Jack Swigert and lunar module pilot Fred Haise. Photo credit: NASA

around the moon and gaining a boost from the lunar gravity. The descent engine was used again two hours after the closest approach to the moon’s surface.

With the support from contractors and universities, the flight control team demonstrated considerable ingenuity under pressure, overcoming the challenges of low power, limited water and lack of other consumables. It was an example of NASA developing innovative solutions that dramatically improved the agency’s capabilities in dealing with the unexpected in years to come.

Availability of lithium hydroxide (LiOH) for removing carbon dioxide from the LM’s air presented one of the serious problems.

figure out what hardware there was in the command and lunar modules,” said Kerwin, who also was a capsule communicator during Apollo 13 and a member of the Skylab 2 crew in 1973.

Smylie’s team improvised a way to join the CM canisters to the LM’s cylindrical canister-sockets by drawing air through a spacesuit hose. The plan now needed to be communicated to the crew.

“I’m sitting at the capsule communicator console and here comes Ed and his team carrying all this stuff,” Kerwin said. “They dumped it down on the floor and Ed says, ‘Kerwin, get down here. We’re going to teach you how to do this so you can tell Jack (Swigert).’”



In spite of the hardships caused by limited power, loss of cabin heat and the critical need to improvise the carbon dioxide removal system, the crew returned safely to Earth on April 17, 1970. The CM safely splashed down in the south Pacific Ocean, four miles from the recovery ship, USS Iwo Jima.

The day after the splashdown, President Richard Nixon awarded the Presidential Medal of Freedom to the crew and the Apollo 13 Mission Operations Team for their

happened, people saw that it was one of NASA's finest hours."

In 1994, Lovell's book "Lost Moon" was published and became the basis the following year for the motion picture adaptation, "Apollo 13," directed by Howard.

In the movie actor Ed Harris, who is cast as Kranz, states, "failure is not an option." Kranz became so associated with the phrase, it was the title of his autobiography published in 2000.

Colorado's 6th district in November 1982. However, he died a month later before being sworn in.

The evening's celebration concluded with Lovell placing the mission of Apollo 13 in historical context.

"The flight was a failure in its initial mission," he said. "However, it was a tremendous success in the ability of people to get together, like the mission control team working with what they had and working



Three Apollo 13 flight directors celebrate the successful splashdown and recovery of the Apollo 13 crew. From the left are Gerry Griffin, giving thumbs up, Gene Kranz and Glynn Lunney. Photo credit: NASA

unyielding efforts during the mission.

Griffin pointed out that a key to the successful effort was teamwork

"You seldom heard the personal pronoun 'I,'" he said. "Most of the time it was 'we,' because we trusted each other."

Lousma, who would later be a part of the Skylab 3 crew in 1973 and command STS-3 in 1982, commented on the professionalism of the crew and flight control team.

"We just responded as we had to," he said. "It was dynamic, people working real hard to find out what the problems were. It was a bunch of people who were trying to solve these problems as they came up. When Ron Howard made the ('Apollo 13') movie and everybody found out what really

"Failure is not an option" was in fact coined by "Apollo 13" screenwriters Al Reinart and Bill Broyles. It is based on similar statements made by Kranz and flight dynamics officer Jerry Bostick as they were interviewed for the movie's dialogue.

Haise went on to command the first, third and fifth Approach and Landing Test free-flight trials of the prototype space shuttle Enterprise at Edwards Air Force Base in California in 1977. During the 1980s and 1990s, Haise served as president of Grumman Technical Services Inc. at Kennedy as part of the Shuttle Processing Contract Team.

After leaving NASA, Swigert was elected to the U.S. House of Representatives from

with the flight crew to turn what was almost a certain catastrophe into a successful recovery."

Proceeds from the Apollo 13 anniversary event benefit the Astronaut Scholarship Foundation (ASF), a nonprofit organization established in 1984 by the six surviving Mercury 7 astronauts. Through the garnered support of astronauts, industry leaders, educational institutions and patrons, ASF awards merit-based scholarships to the best and brightest university students who excel in STEM — science, technology, engineering and mathematics. Since its inception, ASF has awarded over \$4 million in scholarships to more than 370 of the nation's top scholars.





A scale model of the Orion spacecraft is in view at the Orion All Hands meeting April 6 at Kennedy Space Center. Photo credit: NASA/Frankie Martin

Mark Geyer, Orion Program manager at NASA's Johnson Space Center in Houston, praised the NASA and contractor teams at the agency's Kennedy Space Center for a job well done during an Orion flight test overview April 6.

"Not only did we persevere, but we're moving into the next step of exploring the solar system with people," said Geyer, "We could go to the moon, to an asteroid or Mars. All these destinations are possible with Orion."

Orion's first flight test, Exploration Flight Test-1, demonstrated systems associated with controlling many of the top risks determined for the first integrated launch of Orion and the Space Launch System on Exploration Mission-1.

**To read the complete story, visit: <http://go.nasa.gov/1Hocibz>**



# NASA Spinoff



## Mars technologies spawn durable wind turbines

"It all started with ecological life support systems for exploration," says David Bubenheim, a senior research scientist at NASA's Ames Research Center. Sometimes referred to as regenerative life support systems, the concept includes an enclosed self-sufficient habitat that can independently support life for years on end. Such a system aims not only to produce its own food and water but to purify air and convert waste into useful byproducts.

In the early 1990s, NASA was planning for an extended stay on Mars, and Bubenheim and his Ames colleagues were concentrating efforts on creating a complete ecological system to sustain human crewmembers during their time on the Red Planet.

"The main barrier to developing such a system," he says, "is energy." Mars has no power plants, and a regenerative system requires equipment that runs on electricity to do everything from regulating humidity in the atmosphere to monitoring the quality of recycled water.

The Ames group started looking at maximizing energy use efficiency and alternative methods to make power on a planet that is millions of miles away from Earth. They turned to a hybrid concept combining two renewable sources: wind and solar power technologies. Large surface temperature swings on Mars produce windy conditions; extreme examples are the frequent dust storms that can block nearly all sunlight. "When there's a dust storm and the wind is blowing, the wind system could be the dominant power source. When the wind is not blowing and the sun is shining on the surface, photovoltaics could be the dominant source," says Bubenheim.

To develop and test the wind power technology, Ames turned to a remote, harsh

environment here on Earth: the South Pole. "The South Pole was a really good analog for Mars," says Bubenheim. "The technology features for establishing a human habitat on Mars are very similar to the features needed to make something work at the South Pole."

Around the same time that NASA started investigating energy technologies for the Red Planet, the National Science Foundation (NSF) was working on a redesign of their station at the South Pole. To power its operations, NSF uses fuel that it flies to the remote location, but the Foundation recognized the benefits of also using onsite renewable energy technologies.

"In the winter they have small crews and their power requirements are less," says Bubenheim. "In the summers, they bring in larger groups and photovoltaics could supply the necessary additional power. Using renewable energy technology could be a way of reducing the amount of fuel they have to fly in."

### TECHNOLOGY TRANSFER

To advance wind turbine technology to meet the requirements of extremely harsh environments like that on Mars, Ames partnered with NSF and the Department of Energy. "It was clear that a lot of the same features were also desirable for the cold regions of the Earth," says Bubenheim. "NASA took the leadership on the team because we had the longest-term technology -- a Mars turbine."

Years before, NSF had worked with a company called Northern Power Systems (NPS), based in Barre, Vermont, to deploy a 3-kilowatt wind turbine on Black Island off the coast of Antarctica. The main purpose of this turbine was to power communications to the NSF's South Pole station. In 1993, Ames awarded the same company a Small Business

Innovation Research (SBIR) contract to construct a similar wind turbine at the South Pole.

Jonathan Lynch, the chief technology officer at NPS, says the South Pole has less wind than Black Island but is significantly colder. "It's hard to have steels that work in those temperatures," he says. "The cold affects the parts and everything gets extremely brittle. We looked at which materials were appropriate for flexible wires, irons, and steels, and what lubrication systems were going to work and for what temperatures over a long period of time."

In 1997, NPS installed a 3-kilowatt turbine at the South Pole, and then began developing a 100-kilowatt turbine that could function in the same extreme conditions. The first prototypes of the larger turbine were successfully deployed in Kotzebue, Alaska and Golden, Colorado. "They were fully tested in loads to make sure they worked, and we subsequently built them in batches," says Lynch.

By 2000, the wind turbine technology had won an R&D 100 Award from R&D Magazine, and since then, says Bubenheim, "It's been duplicated and put in a lot of places around the globe."

### BENEFITS

Thanks to the public-private partnership, Lynch says NPS simplified the overall concepts of the turbine's function so it has few moving parts; improved the serviceability of the turbine by enabling access to the parts from inside the turbine's tower; and used materials including different types of metals, insulation, and fiberglass that can withstand extreme environmental conditions over long periods of time.

"Turbines traditionally have a hard time being employed in Alaska because they





Northern Power wind turbines pepper the landscape in Bisaccia, Italy. Photo credit: NASA

**Each  
turbine  
produces  
enough energy  
for 25–30 homes**

would typically freeze up and not work in the winter,” says Bubenheim. “Nobody wanted to climb up on the wind turbine and work on it at 40-below zero in the dark.”

Today, the NASA-derived NPS turbine is known as the Northern Power 100, and according to the company, the turbine’s simplicity is what contributes to its durability in harsh, remote environments. “We designed a simple and elegant machine with as few moving parts as possible, to both minimize and simplify maintenance needs,” says Lynch. “We also developed remote communication

technology to support a growing fleet of widely distributed machines.”

The Northern Power 100 begins generating power with winds as low as 6 mph, and each turbine produces enough energy for 25–30 homes. Over the years, NPS has adjusted the turbine’s features to make it applicable for milder climates as well, and the technology has been installed for use in a variety of places, including school and university campuses, residential developments, farms, municipalities, and businesses ranging from candy factories to greenhouses.



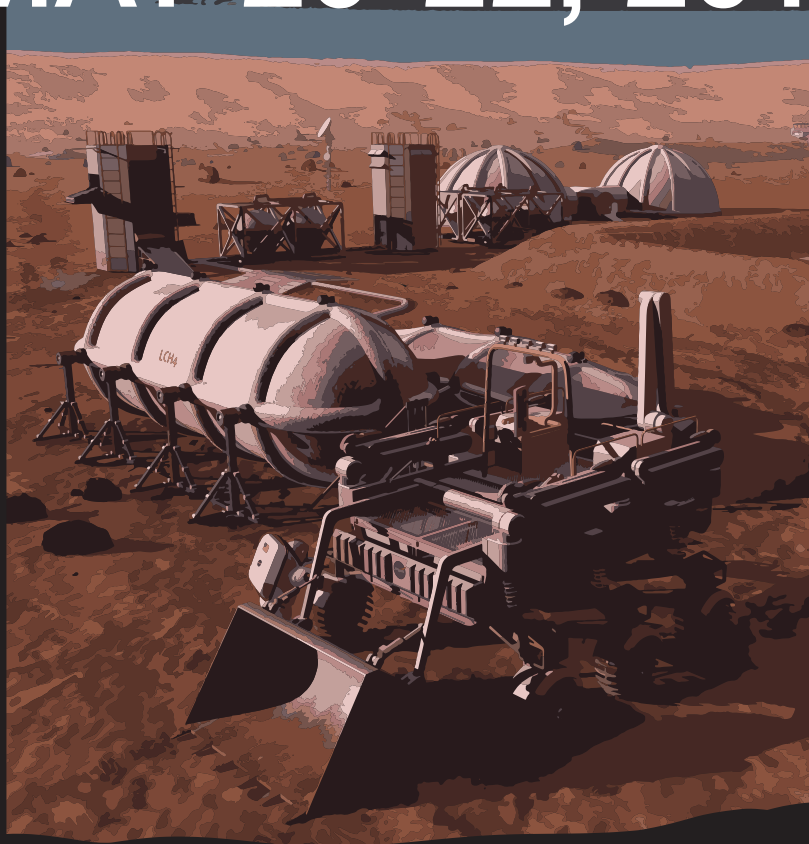
**STAR BOTS**

# EPISODE VI

RETURN OF THE REGOLITH

NASA ROBOTIC MINING COMPETITION

**MAY 20-22, 2015**



**COMING THIS MAY, ROBOTS YOU WILL SEE!**

For more information: <http://go.nasa.gov/1F7FDGX>

National Aeronautics and Space Administration

**John F. Kennedy Space Center**  
Kennedy Space Center, FL 32899

[www.nasa.gov](http://www.nasa.gov)

SPACEPORT MAGAZINE